

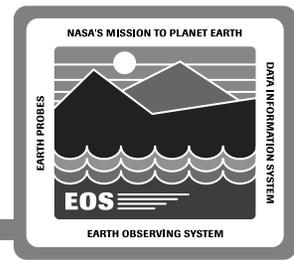
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# Telemetry Subsystem

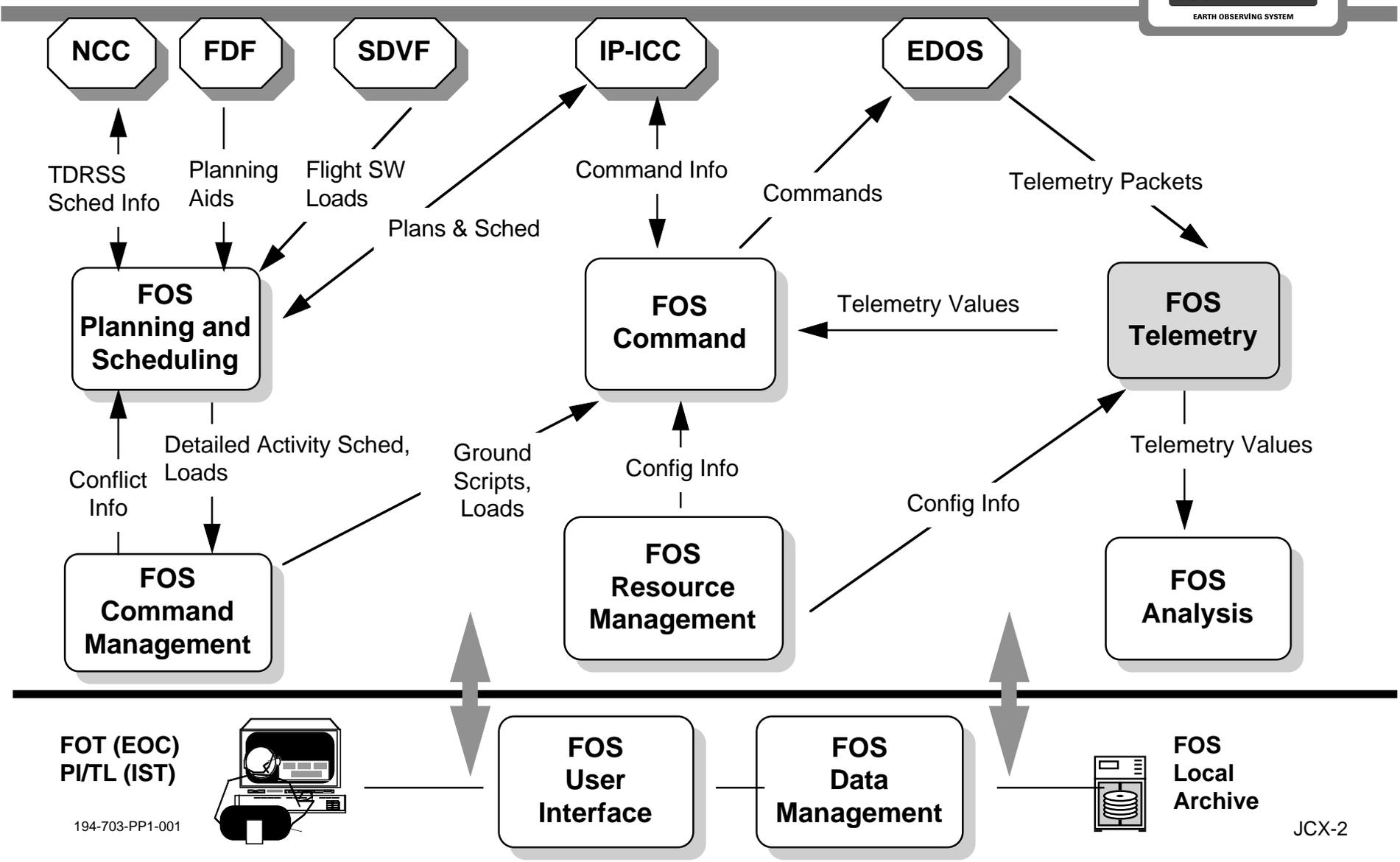
## Jeff Cox

System Design Review - 28 June 1994

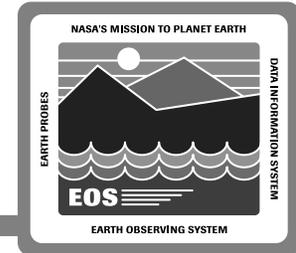
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# FOS Subsystem Diagram



# Telemetry Subsystem Outline



## Telemetry Subsystem Overview

- Design Drivers

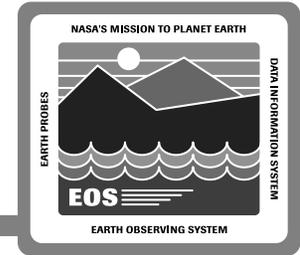
## Telemetry Subsystem Context

- Context Diagram
- Interface Description
- Scenarios

## Telemetry Subsystem Design

- Object Model
- Design Description
- Scenarios

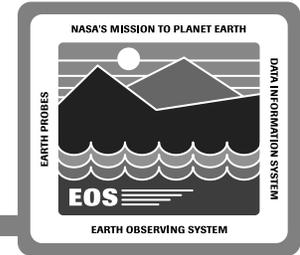
# Telemetry Subsystem Overview



## Telemetry Subsystem Functions

- **Real-time**
  - **Ingest, storage, and decommutation of spacecraft and instrument data for display and analysis**
  - **Ingest, storage, and processing of non-telemetry data from the NCC & EDOS for display and analysis**
  - **Create telemetry data subsets for delivery to Flight Dynamics Facility**
- **Off-line**
  - **Decommutation of historical spacecraft and instrument data for display and analysis**
  - **Processing of historical non-telemetry data from the NCC & EDOS for display and analysis**
  - **Create telemetry data subsets for delivery to Flight Dynamics Facility**

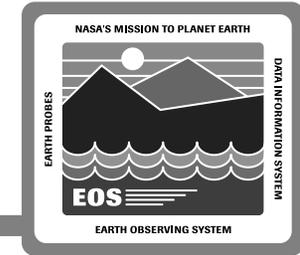
# Telemetry Subsystem Overview (cont.)



**Supports the EOC Operator in monitoring the spacecraft and instrument operations**

**Allows the Instrument Team to monitor spacecraft and instrument operations**

# Telemetry Subsystem Design Drivers



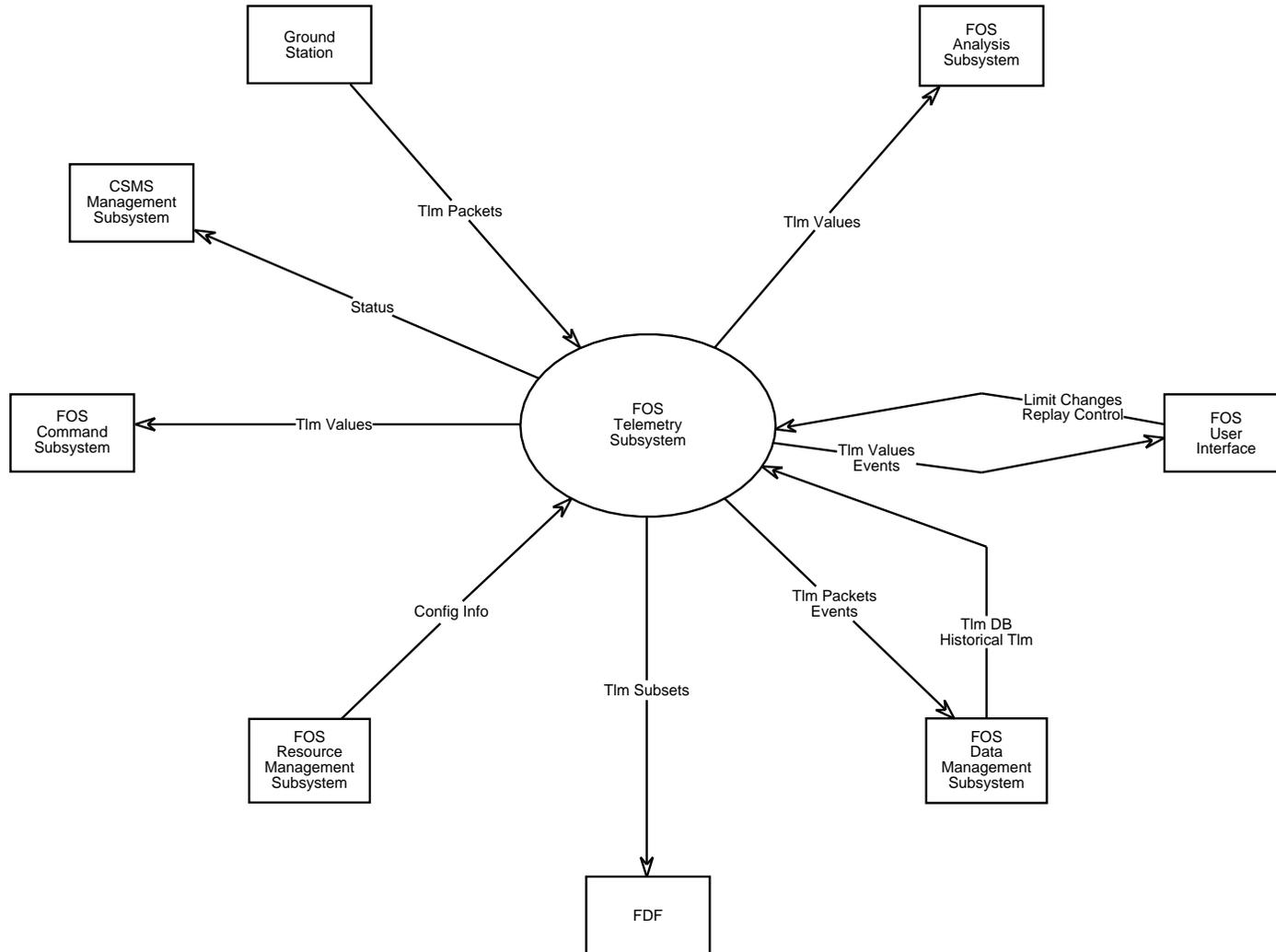
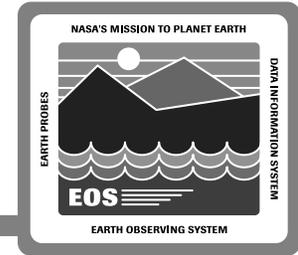
**Process multiple spacecraft and their instrument data simultaneously**

**CCSDS Packet Telemetry**

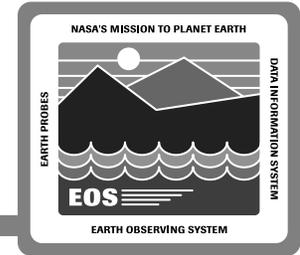
**Performance**

- **Real-time spacecraft and instrument data must be processed at rates up to 50 kbps**
- **Replay processing of historical data must be processed at operator selectable rates of up to 150 kbps**
- **Replay processing of spacecraft recorder instrument housekeeping and engineering data for analysis must be performed at a rate of at least 12:1 for the spacecraft recorder recording period**
- **Receipt and storage of spacecraft recorder data must be performed at rates up to 1.544 Mbps**
- **Receipt and extraction of instrument engineering data from instrument science data must be performed at rates up to 1.544 Mbps**

# Telemetry Subsystem Context Diagram



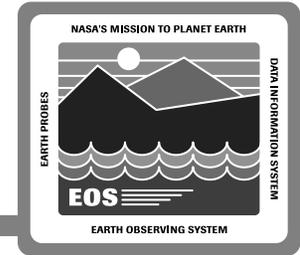
# Telemetry Subsystem Context Description



**Telemetry Subsystem interfaces support the following scenarios with respect to real-time and off-line operations of the EOS spacecraft and instrument**

- **Spacecraft & Instrument telemetry processing**
- **Spacecraft Recorder data ingest and storage**
- **Spacecraft & Instrument Dump data ingest and storage**
- **Non-telemetry data from NCC and EDOS (includes ground stations)**
- **Replay processing of historical data**
  - **Spacecraft & Instrument telemetry data**
  - **Spacecraft Recorder data**
  - **Non-telemetry data**
- **Telemetry Subset data for FDF**

# Telemetry Subsystem Context Description (cont.)

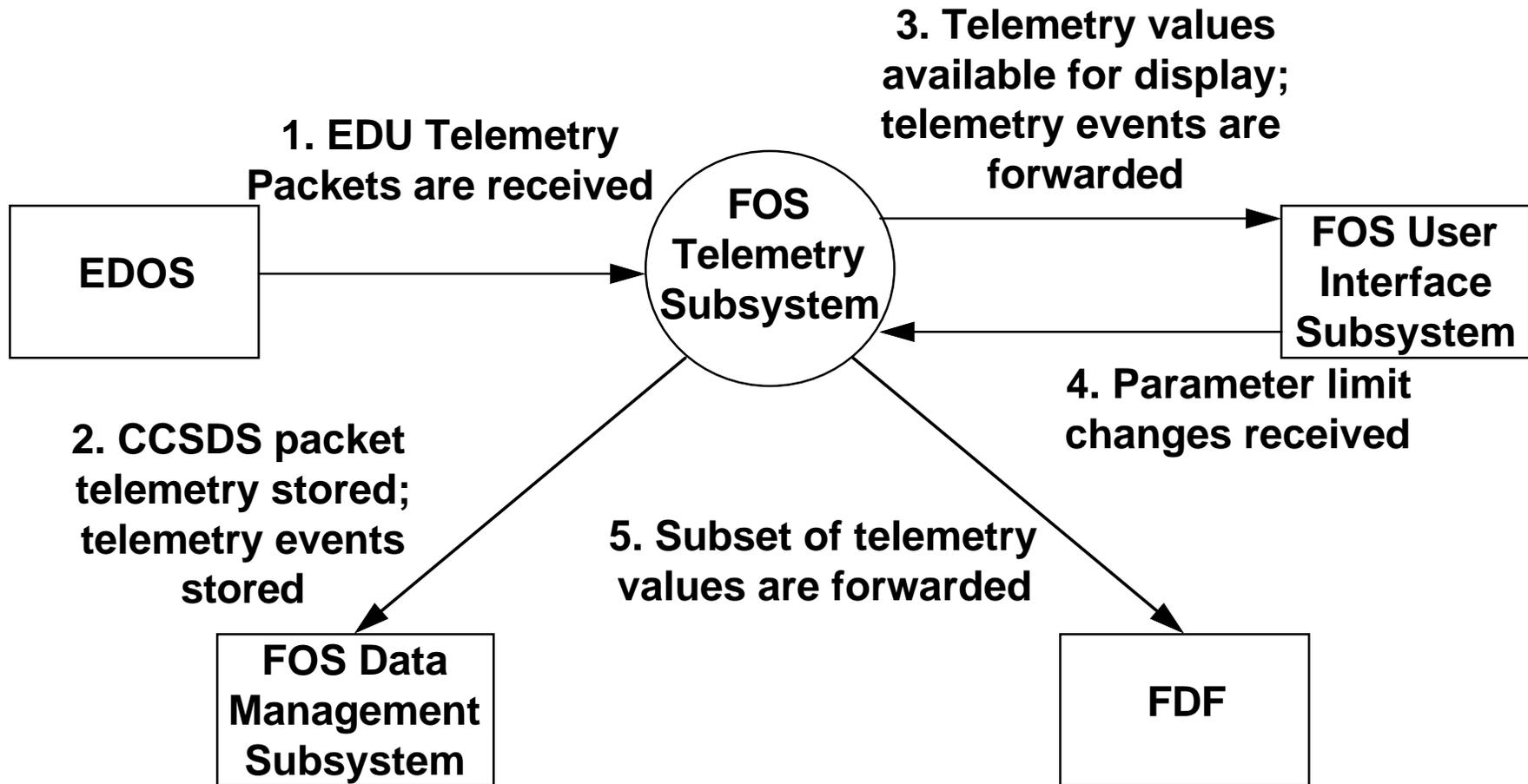
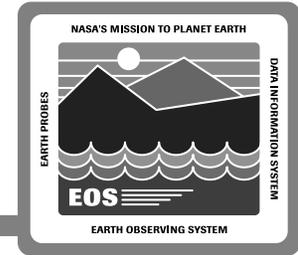


## Facilitating Interfaces

- **FOS Resource Management Subsystem provides configuration information (e.g., return link service information, database identification)**
- **FOS Data Management Subsystem provides Telemetry definitions**
  - **Parameter decommutation definitions**
  - **Telemetry Subset definitions**
- **CSMS Management Subsystem receives telemetry subsystem status**

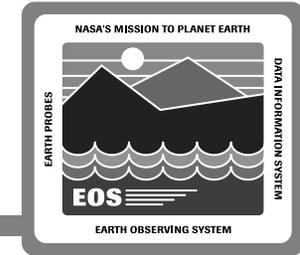
# Telemetry Subsystem

## Real-time Telemetry Scenario



# Telemetry Subsystem

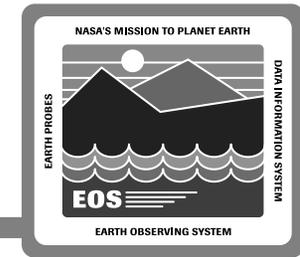
## Real-time Telemetry Scenario



- (1) EDOS Data Unit (EDU) telemetry packets are received from EDOS
  - EDU packet contains CCSDS packet telemetry data
- (2) CCSDS packet telemetry are stored at the FOS Data Management Subsystem
  - Application ID designates telemetry type
    - Spacecraft & Instrument telemetry data (H/K, H&S, etc.)
      - Spacecraft Recorder data
    - Spacecraft & Instrument Dump data
  - Telemetry events are stored
- (3) Telemetry parameters and events are provided to the FOS User Interface
  - Allows EOC operators and the Instrument Teams to monitor spacecraft and instrument health and safety

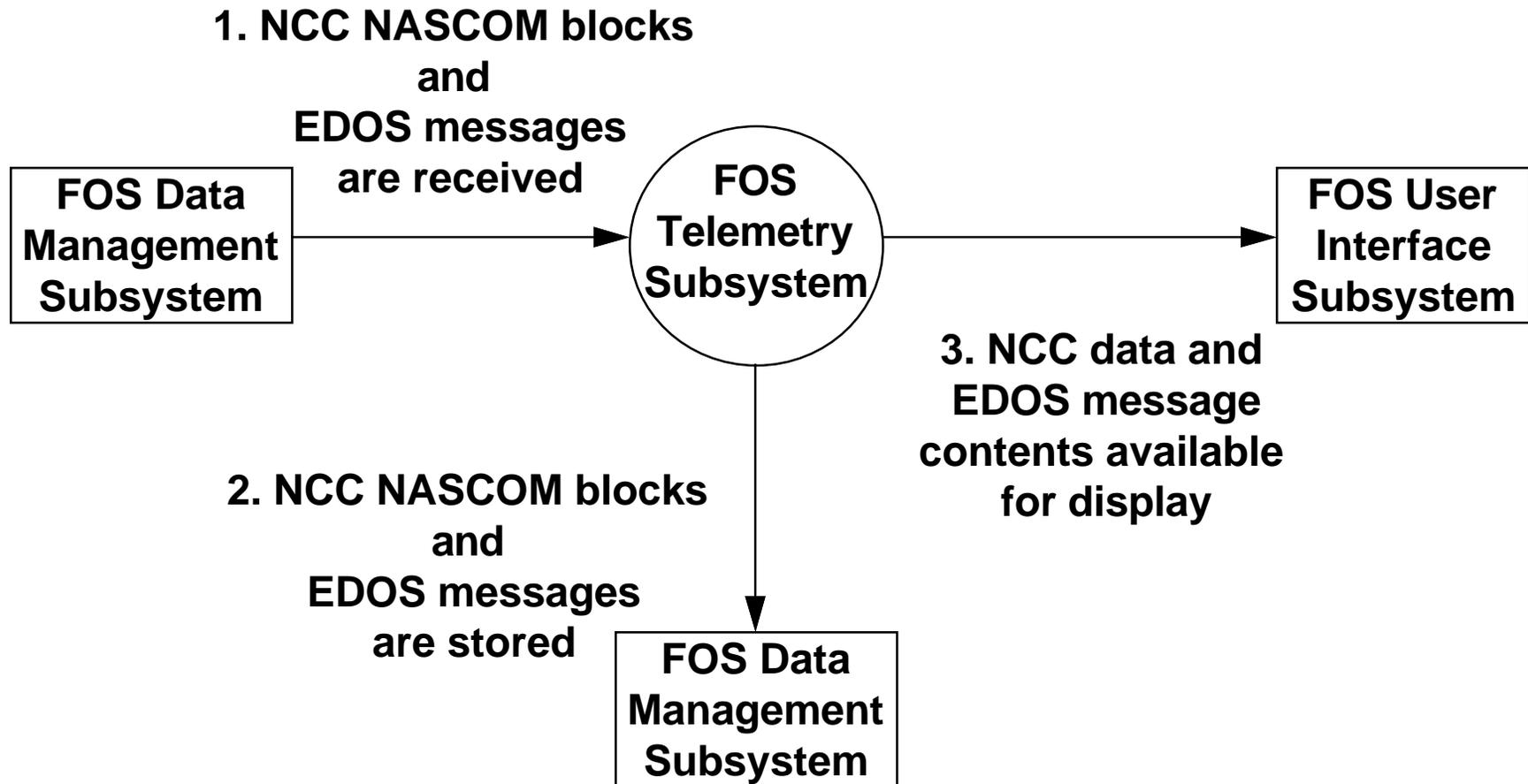
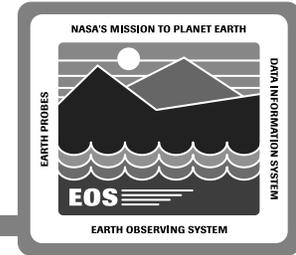
# Telemetry Subsystem

## Real-time Telemetry Scenario

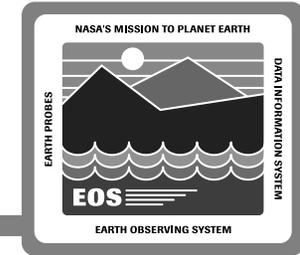


- (4) Parameter limit changes received from FOS User Interface
  - Limit changes are temporary
- (5) Subset of telemetry parameters forwarded to FDF
  - Subsets are forwarded at FDF determined interval

# Telemetry Subsystem Non-Telemetry Scenario

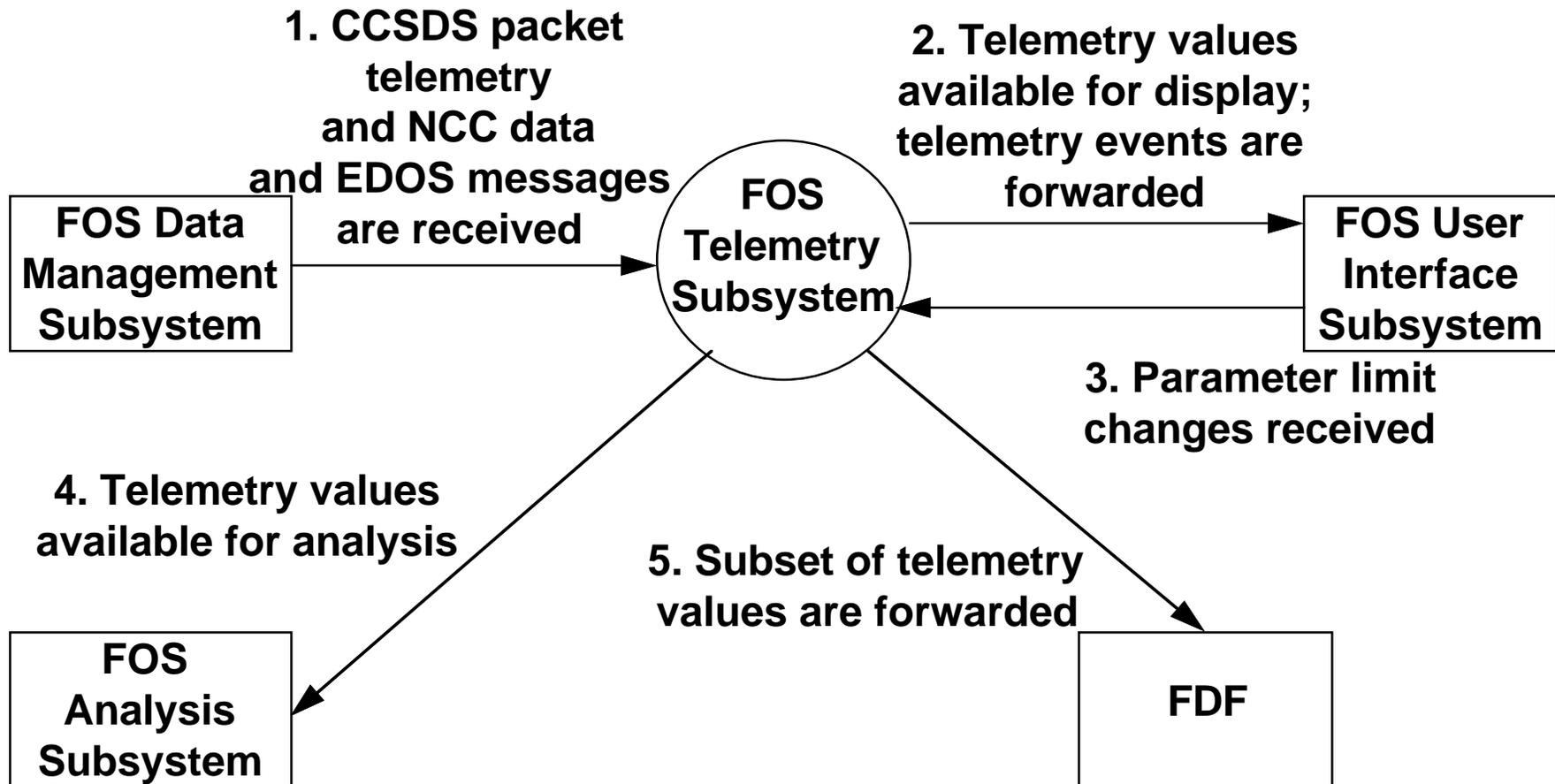
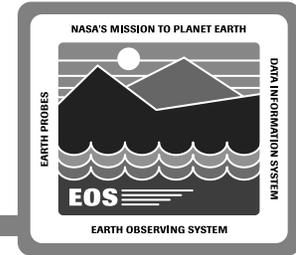


# Telemetry Subsystem Non-Telemetry Scenario

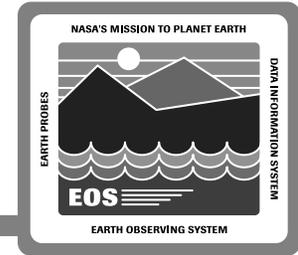


- (1) NCC data and EDOS messages are received from Ecom/EDOS**
  - **NCC data are in NASCOM 4800-bit blocks**
- (2) NASCOM blocks and EDOS messages are stored at the FOS Data Management Subsystem**
- (3) NCC data and EDOS messages are processed for display by the FOS User Interface**
  - **Allow EOC operator to monitor ground status**

# Telemetry Subsystem Replay Scenario

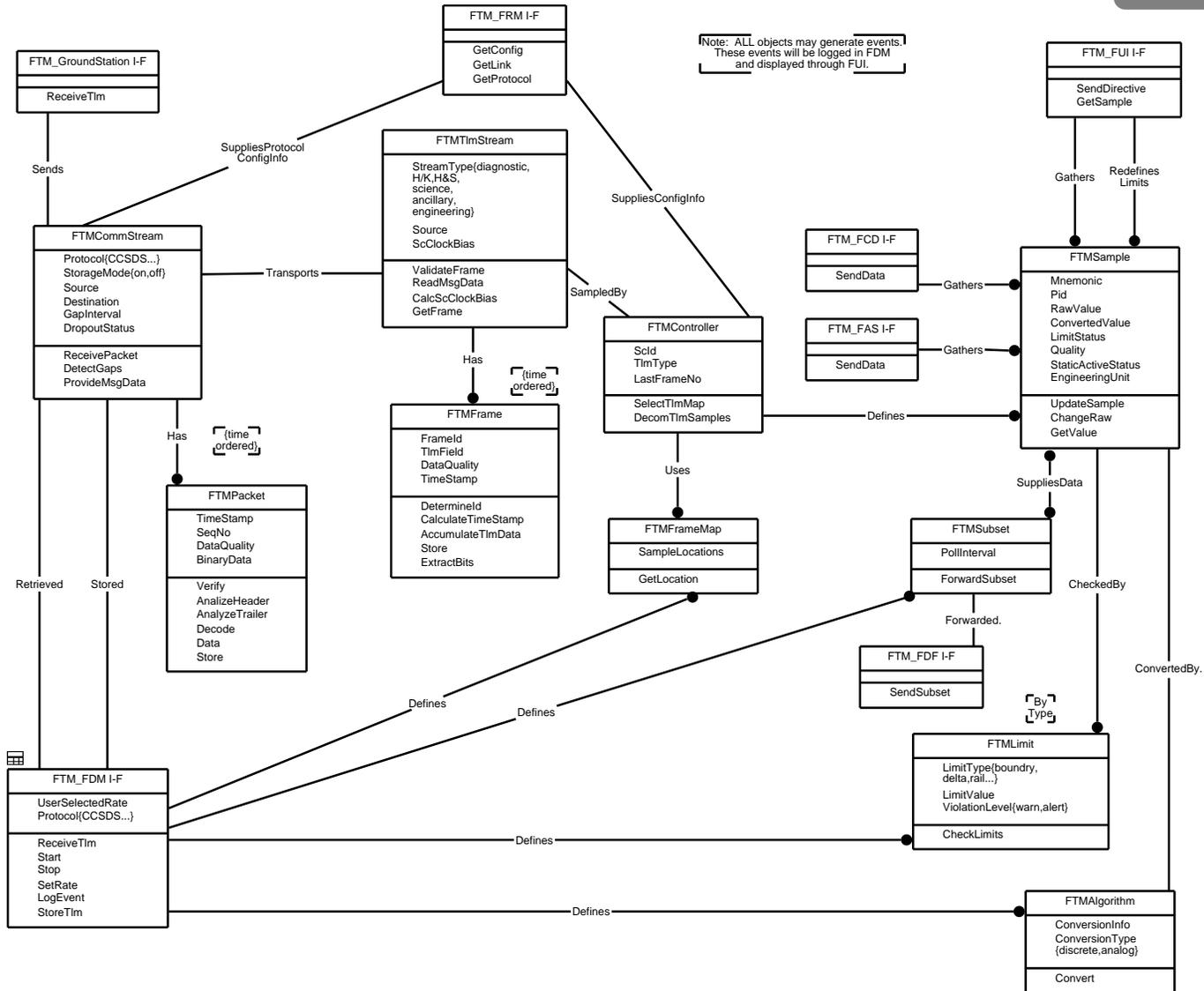
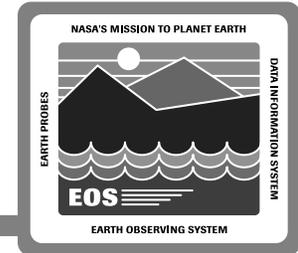


# Telemetry Subsystem Replay Scenario

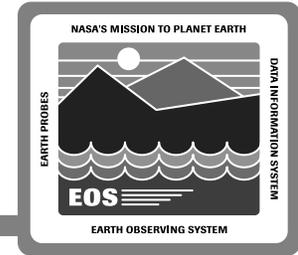


- (1) Data are received from FOS Data Management Subsystem**
  - **CCSDS packet telemetry data**
  - **NCC data packets**
  - **EDOS ground element messages**
- (2) Telemetry parameters and events are provided to FOS User Interface**
  - **Allows EOC operator and Instrument Team to review historical data**
- (3) Parameter limit changes received from FOS User Interface**
  - **Limit changes are temporary**
- (4) Telemetry parameters available for processing by the FOS Analysis Subsystem**
- (5) Subset of telemetry parameters forwarded to FDF**
  - **Subsets are forwarded at FDF determined interval**

# Telemetry Subsystem Object Model



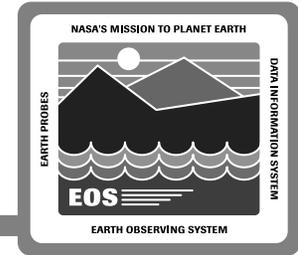
# Telemetry Subsystem Design Description



## Object Model Scope

- **Telemetry Processing of a single data type received from an EOS spacecraft and its instruments or a ground system element for a single EOS spacecraft contact or replay**
- **Telemetry Processing for multiple spacecraft is realized via multiple instances**
- **Telemetry Processing for multiple contacts may be handled via new instances or reconfiguration of a given instance**

# Telemetry Subsystem Design Description (cont.)



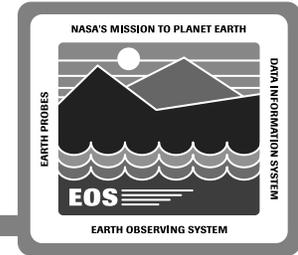
## FTMCommStream Class

- Performs CCSDS or NASCOM protocol processing
- Allows a single point of control for providing data to the Data Management Subsystem for the FOS archive

## FTMTImStream Class

- Spacecraft and Instrument data is recovered as individual data units
  - Data is time-ordered and packaged into FTMFrame classes for processing by FTMController class
- NCC data and EDOS messages are time-ordered only

# Telemetry Subsystem Design Description (cont.)



## FTMController Class

- Initiates parameter decommutation
  - Spacecraft and Instrument parameters
  - NCC data and EDOS message
  - Derived parameters

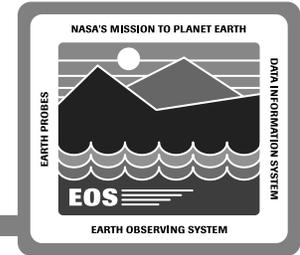
## FTMSample Class

- Contains data for a single telemetry parameter
  - Performs Limit checks and Conversion
  - Temporary limits are defined
  - Parameter values are accessible for telemetry subsetting and to other FOS Subsystems (i.e., User Interface, Analysis, and Command)

## FTMSubset Class

- Gathers and sends FDF data

# Telemetry Subsystem Design Description (cont.)



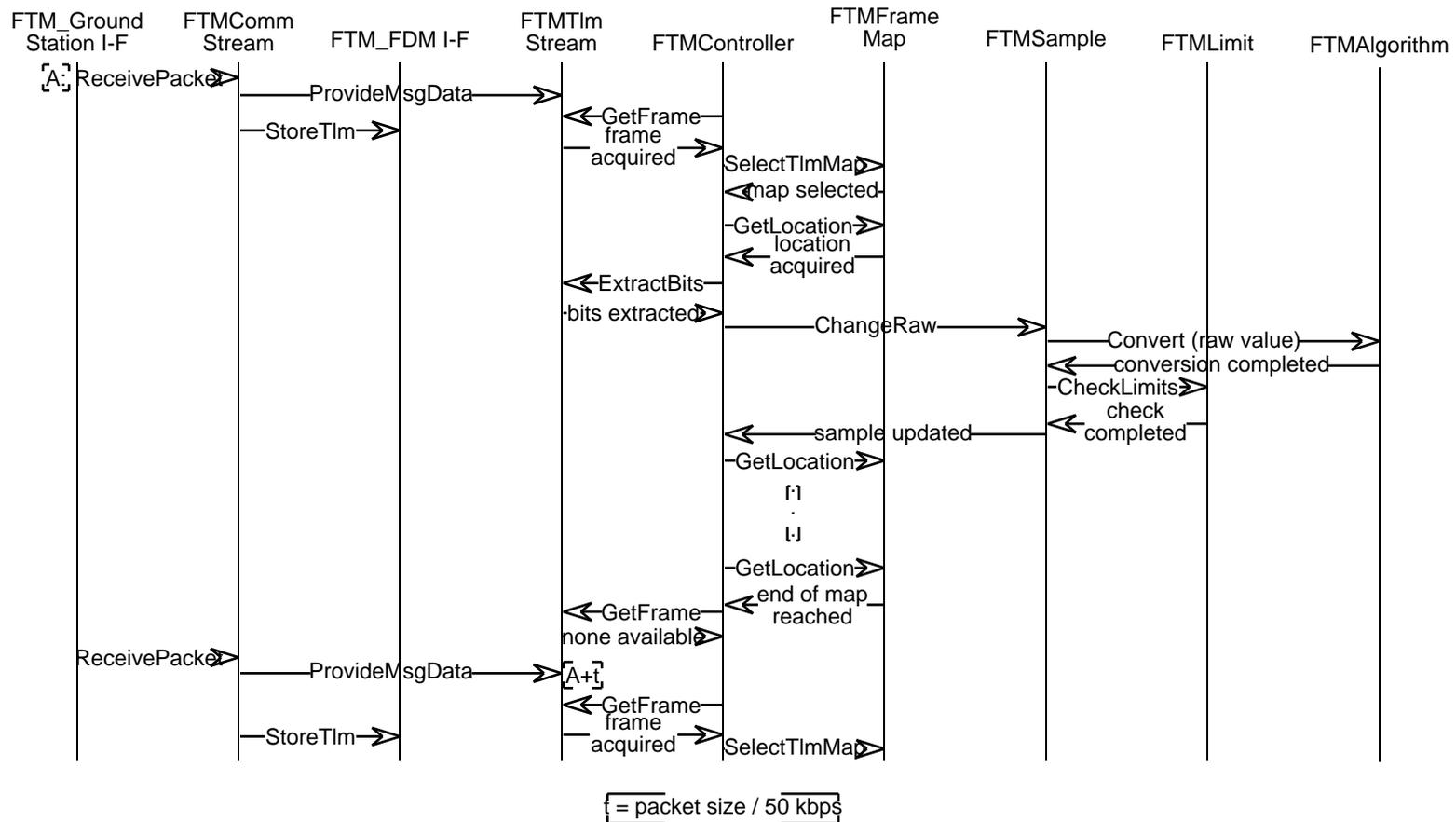
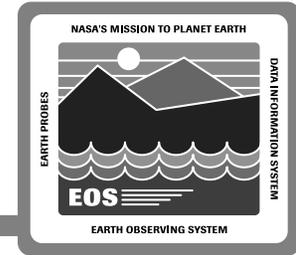
## Mission Specific Hooks

- **FTMTImStream**
  - Packet telemetry recovery based on spacecraft transmission architecture
    - Source Packet Segmentation**
    - AM-1 Master/Major Cycle**
- **FTMFrameMap**
  - Defines locations of spacecraft and instrument data in packet telemetry

## Evolutionary Hooks

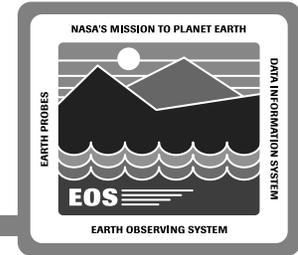
- **FTM\_GroundStation I-F**
  - Expandable to handle other return link paths

# Telemetry Subsystem Real-Time Telemetry Scenario



# Telemetry Subsystem

## Real-Time Telemetry Scenario



**Process spacecraft and instrument data received in real-time**

- Real-time data must be processed at rates up to of 50 kbps
- Strip CCSDS packet from EDOS telemetry packet
- Forward CCSDS application data for packet telemetry recovery
- Store CCSDS packet

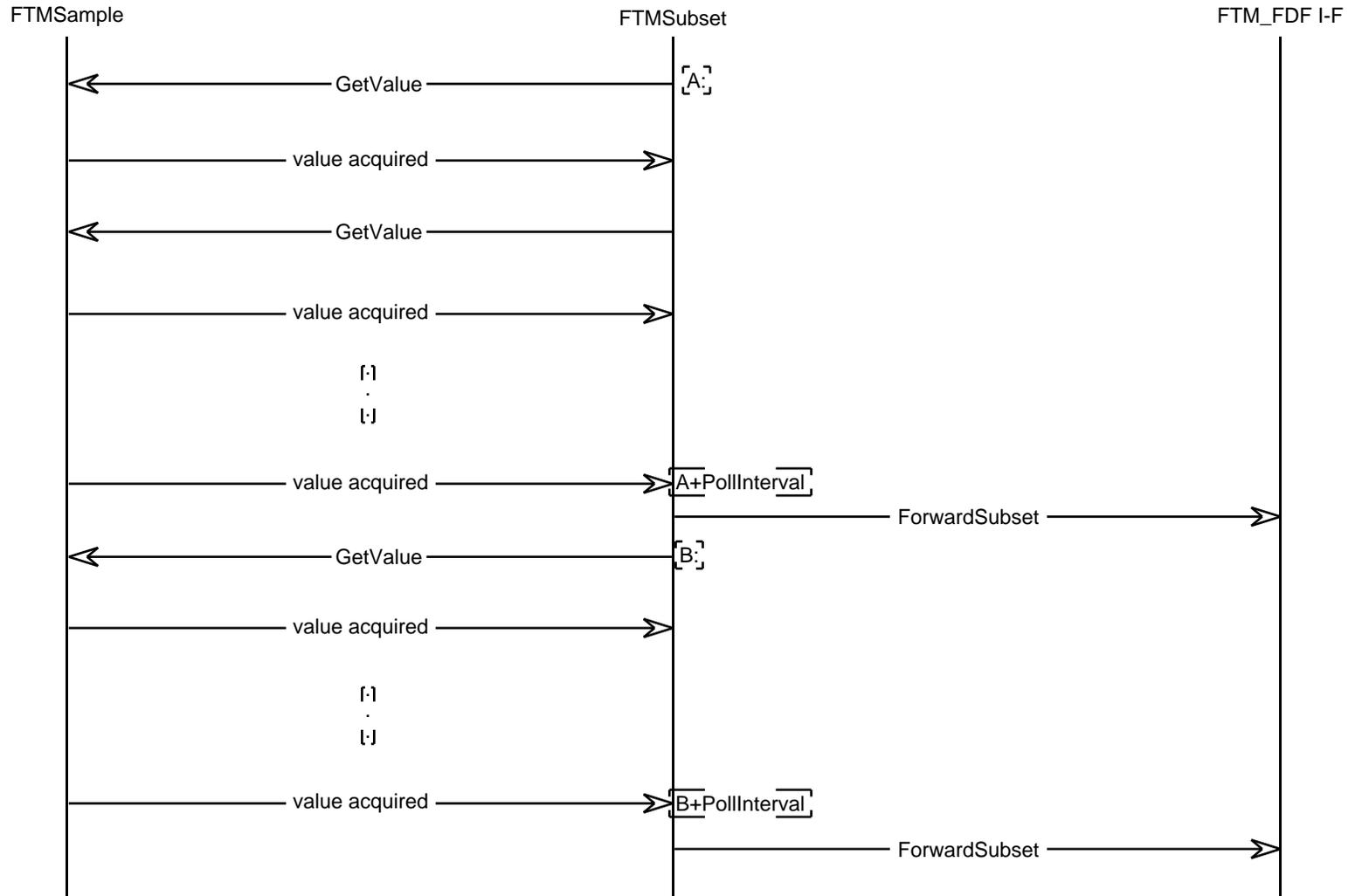
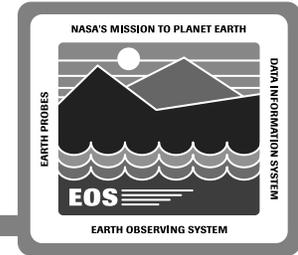
**Process packet telemetry data**

- Get the parameter decommutation map for the packet
- Extract data bits for each parameter identified in the decom map

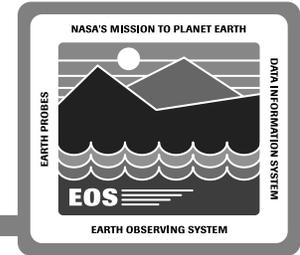
**Process parameter data**

- Parameters are processed as they are identified in the decom map
- Convert raw data bits
- Limit check parameter value

# Telemetry Subsystem FDF Subset Scenario



# Telemetry Subsystem FDF Subset Scenario



## Gather Telemetry values

- Interval for acquiring values is determined by the FDF

## Forward Telemetry sample to FDF

- Telemetry subset is forward to FDF after gather has completed